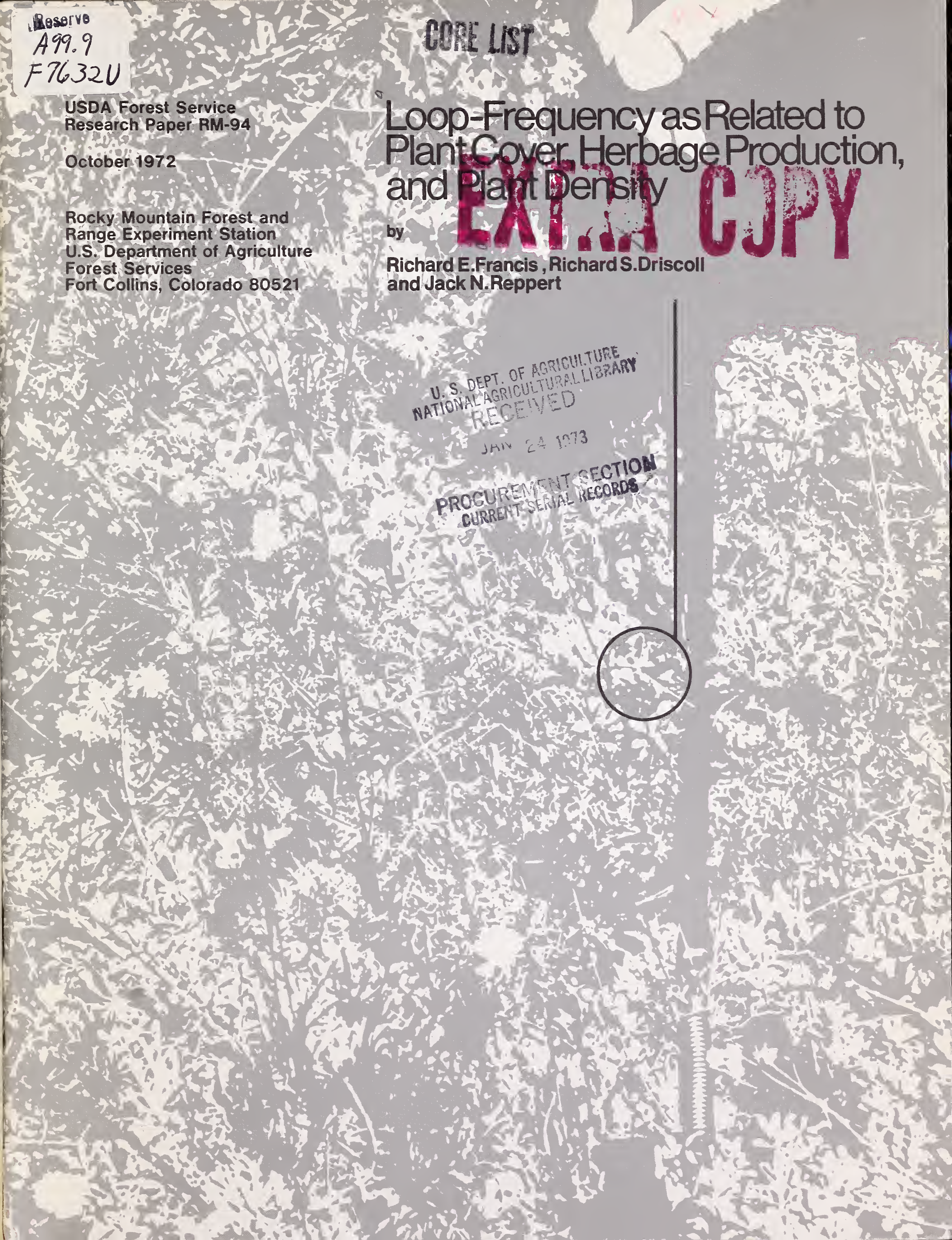

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Rocky Mountain Forest and
Range Experiment Station
U.S. Department of Agriculture
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Fort Collins, Colorado 80521

# Loop-Frequency as Related to Plant Cover, Herbage Production, and Plant Density



by

Richard E. Francis, Richard S. Driscoll
and Jack N. Reppert

### Abstract

Frequency measured by the 3/4-inch loop technique was compared to estimates of plant basal cover, foliar cover, herbage production, and density. The relationship between loop-frequency and the other parameters were rarely significant or consistent as determined by regression and correlation. Loop-frequency unpredictably overrated foliar and basal plant cover on the basis of ratio estimates, a relative measure of bias. Therefore, frequency estimated by the 3/4-inch loop technique can be equated only to itself and not used to make inferences about other plant community parameters.



**Keywords:** Loop-frequency, plant basal cover, plant foliar cover, herbage production, plant density, bias (ratio estimates).

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# Loop-Frequency as Related to Plant Cover, Herbage Production, and Plant Density

by

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## Contents

2001

# Loop-Frequency as Related to Plant Cover, Herbage Production, and Plant Density. [Ecology]

~~Richard~~ E. Francis, ~~Richard~~ S. Driscoll, and ~~Jack~~ N. Reppert

Three-quarter-inch loop-frequency is a vegetation measurement technique which has been used to determine change in vegetation or analyze plant communities. It is an integral part of the 3-step procedure developed by Parker (1951), and was basically designed to detect change in range condition. Loop-frequency estimates presence or absence of plant species on a series of small plots.

Reports have been published discussing relationships between plant frequency estimated by the 3/4-inch loop and other methods for analyzing vegetation. Kinsinger et al. (1960) compared the loop method against line intercept and variable plots to estimate shrub crown cover. They reported that the loop method estimated cover significantly higher than "true cover" or line intercept. Johnston (1957) stated that, "The loop method was the most rapid in the field, detected least species, and gave the most variable data," when compared to the line intercept and vertical point quadrat methods for measuring grassland vegetation. However, loop-frequency has often been interpreted as an index to other community characteristics such as plant cover or density.

The objectives of this study were to determine the relationships between loop-frequency as a plant community measurement and (1) plant cover measured by line intercept (basal), point quadrat (basal), and ocular estimate (foliar), (2) herbage production, and (3) density (numbers per unit area). If loop-frequency was dependably related to these other attributes, it could be used as an index to those attributes measured and provide additional information about plant community structure and change.

## Literature

Loop-frequency has been obtained by recording perennial plant species rooted within 3/4-inch circular plots systematically located along 100-foot transects. When no plant base occurred within the loop, plant litter, rock, bare soil, or moss was recorded depending on which one of the items occupied 50 percent or more of the loop area (Parker 1951).

Tests of the loop-frequency technique have been reported by several researchers (Sharp 1954, Johnston 1957, Hutchings and Holmgren 1959, Parker and Harris 1959, Strickler 1961, Reppert and Francis[2] ). The estimates of plant or soil factors within a 3/4-inch diameter loop has been referred to as a cover or density index (Parker 1951). In reality, it should be interpreted only as loop-frequency (Hutchings and Holmgren 1959) or simply frequency (Hyder et al. 1963).

Plant frequency depends on density (number per unit area) and pattern (distribution of plants) (Greig-Smith 1964). Consequently, these dependencies require consideration of various quadrat sizes to obtain satisfactory species or plant group frequency data (Hyder et al. 1965). Curtis and McIntosh (1950) and Aberdeen (1958) further emphasized that quadrat-frequency data were difficult to interpret as plant cover because of the density/dispersion dependency. In addition, Hutchings and Holmgren (1959) pointed out that loop-frequency depends upon plant shape and size, which also affects cover.

A positive bias between loop-frequency and basal or foliar cover has been reported (Parker 1950, Johnston 1957, Hutchings and Holmgren 1959, Kinsinger et al. 1960). Bias is defined as the ratio of loop-frequency to cover (Hutchings and Holmgren 1959) and approaches unity when loop-frequency and cover are nearly the same. Frequency/cover ratios were as high as 15.0 for small plants, but approached 1.0 for larger plants such as shrubs with large crowns. These results were similar to those of Parker and Harris (1959) who showed a bias of 0.97 for big and silver sagebrush[3] in California and 7.5 for grasses in Arizona.

[2]*Reppert, Jack N., and Richard E. Francis. Interpretation of trend in range condition from 3-step data. (Manuscript in preparation at Rocky Mt. Forest and Range Exp. Stn., Fort Collins, Colo.)*

[3]*Common and botanical names of plants mentioned are listed inside the back cover.*

Smith (1962) felt that changes in loop-frequency might serve as a reliable index to changes in cover provided plant sizes and bias remained fairly constant. Parker and Harris (1959) cautioned against using loop-frequency as a plant cover index when plant diameters were smaller than 1 to 2 inches, and where it cannot be assumed that the plant-size distribution remains unchanged over time.

## Methods

### Study Areas

Four areas were selected to represent a variety of plant communities. The Wild Bill Cattle Allotment is in the ponderosa pine-bunchgrass type on the Coconino National Forest, northwest of Flagstaff, Arizona, at 7,600 feet (Pearson and Jameson 1967). The Manitou Experimental Forest, also a pine-bunchgrass type, is located northwest of Colorado Springs, Colorado in the Pike National Forest at 7,700 feet. Manitou differed from Wild Bill in that ponderosa pine occurred in open-to-dense stands interspersed with untimbered parks (Smith 1967). The specific study site at Manitou was located in one of these parks. The Harvey Valley Allotment, northwest of Susanville, California in the Lassen National Forest, is at 5,600 feet (Ratliff et al.[4]). Three community types were selected at Harvey Valley: meadow, open grassland, and ponderosa pine-bunchgrass. The Carter Mountain-Meeteetse Creek Allotments are on the Shoshone National Forest south of Cody, Wyoming in an alpine type on an 11,000-foot volcanic plateau (Strasia et al. 1970).

### Vegetation Measurements

**Loop-frequency.**—Loop-frequency was obtained according to standard procedures for the 3-step technique. In some cases transect length and numbers per location differed. At all locations, loop-frequency was obtained from the same transects from which other measurements were made.

**Basal cover.**—Plant basal cover, estimated by line intercept (Canfield 1942), was obtained at Manitou for comparison with loop-frequency. In 1967, one hundred 20-foot transects were measured. Sample size was reduced to 20 transects in 1968. These same transects were measured twice in 1969, June and August, to evaluate the relationship of the two techniques to detect plant community seasonality. The transect was the unit of comparison between the two techniques.

The vertical point quadrat method for measuring plant basal cover (Levy and Madden 1933) was used at four plot locations in each of the three vegetation types at the Harvey Valley area for comparisons with loop-frequency. Thirty transects 100 feet long were established at each location. A 3-point vertical frame, oriented perpendicular to the transect line, was systematically placed at 34 loci along each transect. The same transects were used to obtain loop-frequency data. In all cases, the transect was the sample unit.

**Foliar cover.**—Ocular estimates of foliar cover (Brown 1954) and loop-frequency were obtained on the Carter Mountain-Meeteetse Creek Allotments. Two 3-transect clusters, each transect 100 feet long, were randomly located within uniform sites at each of three exclosure locations, one cluster inside and one outside each exclosure. Cover was estimated by 10 percent classes on ten 4- by 8-inch plots systematically placed along each transect.

**Production.**—Within each of seven range units at Wild Bill, fifteen 100-foot permanent transects were established. Estimates of herbage production were obtained from three clipped plots systematically located along each transect. These plots represented one of a pair used for obtaining production-utilization by the paired-plot method (Klingman et al. 1943). The same transects were used to obtain loop-frequency data to provide comparisons between the two measurements. Four years of information, 1965-68, were obtained.

**Density.**—Species density (Oosting 1956) was obtained at Manitou using a 1- by 20-foot plot frame along the same transects used for basal cover and loop-frequency.

These measurement techniques, excluding loop-frequency, have been widely used and tested. They provide reliable estimates, with limited bias, of the plant community characteristics they were designed to measure (Brown 1954, NAS-NRC 1962, Hutchings and Pase 1963).

### Analysis

Linear regression and correlation were used to determine the relationship between loop-

[4] *Ratliff, Raymond D., Jack N. Reppert, and R. J. McConnen. Rest-rotation grazing at Harvey Valley—range health, cattle gains, and economics. (Manuscript in preparation at Pac. Southwest Forest and Range Exp. Stn., Berkeley, Calif.)*

frequency (the independent variable) and estimates of basal cover, foliar cover, production, and plant density. For each comparison, data from a transect represented an observation for regression.

Items chosen for analyses were as follows:

1. Loop-frequency versus percent basal cover (line intercept) for total plants and six species (Arizona fescue, blue grama, mountain muhly, trailing fleabane, pussytoes, and fringed sagebrush) by measurement date.
2. Loop-frequency versus percent basal cover (point quadrat) by vegetation type for total plants, three vegetation groups (grasses, forbs, and grasslikes), soil, and litter.
3. Loop-frequency versus percent foliar cover for total plants, two species (whiproot clover and alpine avens), and three vegetation groups (grasses, forbs, grasslikes) inside all exclosures, outside all exclosures, and all exclosure sites combined.
4. Loop-frequency versus production for total plants and eight species (crested wheatgrass, intermediate wheatgrass, mountain muhly, Arizona fescue, bottlebrush squirreltail, fleabane, sedge, and Fendler ceanothus) by range unit for each year and all years combined.
5. Loop-frequency versus density for six species (same species as 1 above) by measurement date.

Only correlation coefficients of 0.75 or greater at the 5 percent level of significance were retained. A coefficient of 0.75 accounts for about 50 percent of the variation in the dependent variable (Y). This constraint was chosen, therefore, as being statistically as well as biologically important.

Ninety-five percent confidence intervals for the true mean value of Y ($\bar{Y}$) for a given X and the slope of regression line ($\beta$) were determined when a consistently significant relationship occurred for a particular species, plant group, or soil surface characteristic. A consistently significant relationship is defined as 100 percent of the correlation coefficients for a particular test item having significant ($P = 0.05$) r values of 0.75 or greater over time.

Bias was calculated using loop-frequency data and estimates of basal and foliar cover for vegetation classes, primary plant species, and total plant species. Bias for soil and litter was calculated from data obtained by point quadrat. Bias was not calculated for either production or density because these two measurements, not being percentages, have no absolute limit as does loop-frequency or cover.

## Results and Discussion

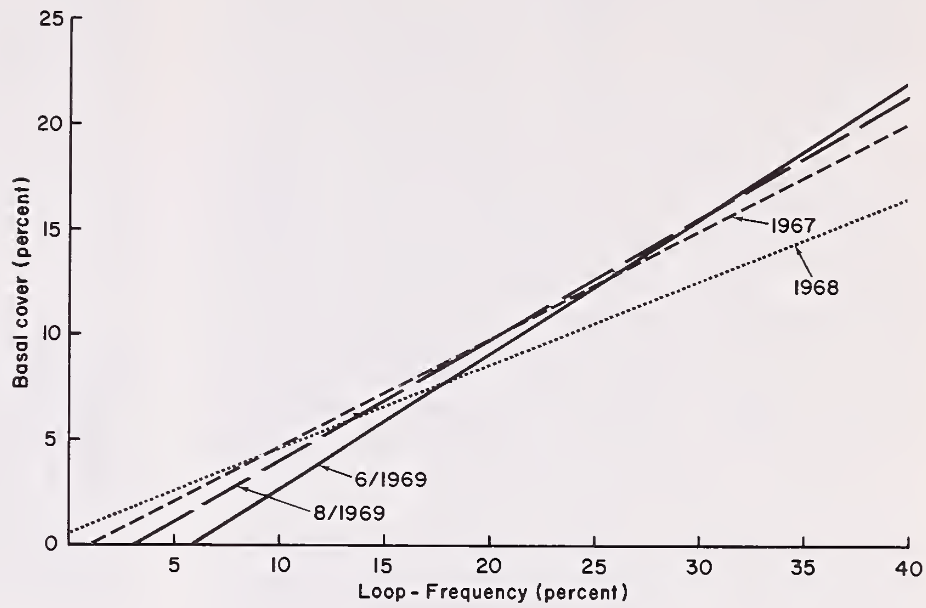
A total of 608 linear regressions were made comparing loop-frequency against four other plant community characteristics. Only 122 of the total correlation coefficients were statistically significant at $P = 0.05$ and $r \geq 0.75$ (table 1).

Table 1.--Significant correlation coefficients obtained comparing 3/4-inch loop-frequency to other vegetation measurements

| Vegetation type | Comparative parameters | Total tests | No. significant with $r \geq 0.75$ (P=.05) | (P=.01) |
|---|---|---|---|---|
| Ponderosa pine-bunchgrass (Manitou) | Frequency vs. basal cover (line intercept) | 252 | 81 | 44 |
| Meadow (Harvey Valley) | Frequency vs. basal cover (pt. quadrat) | 24 | 0 | 0 |
| Open-grassland (Harvey Valley) | Frequency vs. basal cover (pt. quadrat) | 24 | 0 | 0 |
| Ponderosa pine-bunchgrass (Harvey Valley) | Frequency vs. basal cover (pt. quadrat) | 22 | 0 | 0 |
| Alpine (Carter Mtn.) | Frequency vs. foliar cover | 15 | 0 | 0 |
| Ponderosa pine-bunchgrass (Wild Bill) | Frequency vs. herbage production | 175 | 15 | 13 |
| Ponderosa pine-bunchgrass (Manitou) | Frequency vs. density | 96 | 26 | 18 |
| TOTAL | | 608 | 122 | 75 |

1967: Y=-0.50+.5165X; 95% CI($\bar{Y}$)= 9.0630±8.5794; r=.75**
1968: Y= 0.52+.4040X; 95% CI($\bar{Y}$)= 8.9400±5.8769: r=.86**
6/1969: Y=-3.76+.6475X; 95% CI($\bar{Y}$)=11.4700±6.9093; r=.93**
8/1969: Y=-1.81+.5821X; 95% CI($\bar{Y}$)=10.0600±9.5410; r=.82**

*Figure 1.--Loop-frequency (X) versus basal cover (Y) measured by line intercept for blue grama; four measurement periods--Manitou. (CI for β not shown)*




## Basal Cover versus Loop-Frequency ... Manitou

Loop-frequency was tested against basal cover measured with line intercept by 252 linear regressions. Eighty-one significant correlation coefficients were identified (table 1). Only eight of these had a consistently significant relationship for two species over the four measurement periods; blue grama (fig. 1) and mountain muhly (fig. 2). However, the wide confidence intervals indicated doubtful reliability of the relationships. The remainder of the significant correlations were scattered among the other species and measurement periods.

Estimates of relative bias between loop-frequency and basal cover were calculated for six species and vegetation groups. The mean bias for all plants ranged from 2.3 to 2.4 for the four measurement periods (table 2). The largest range in bias was obtained for trailing fleabane (12.5 to 28.0) and the sedge species (2.4 to 20.0). The most consistent bias estimates for a vegetation group and individual species were obtained for all grasses (1.8 to 2.1) and especially for blue grama within that group.

In general, bias estimates were highly erratic except for those species previously mentioned. The wide confidence bands, even with high correlation coefficients, places doubt about an acceptable relationship between the two methods (figs. 1, 2).

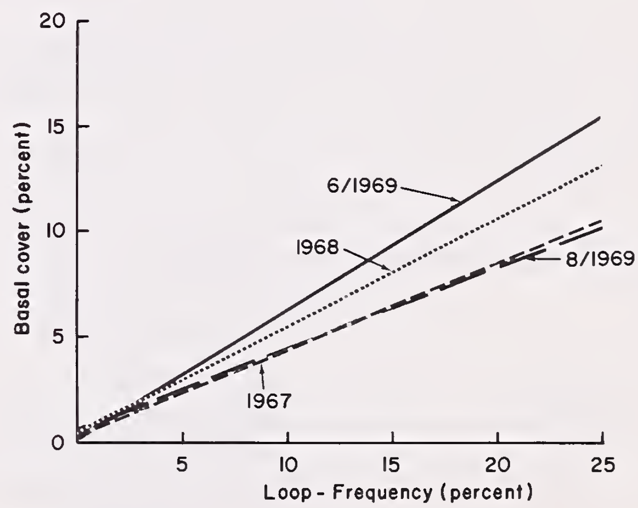



*Figure 2.--Loop-frequency (X) versus basal cover (Y) measured by line intercept for mountain muhly; four measurement periods --Manitou. (CI for β not shown)*

1967: Y=.32+.4097X; 95% CI($\bar{Y}$)=2.8450±2.4601; r=.80**
1968: Y=.47+.5177X; 95% CI($\bar{Y}$)=4.0600±3.2794; r=.89**
6/1969: Y=.32+.6067X; 95% CI($\bar{Y}$)=4.7300±4.7982; r=.83**
8/1969: Y=.67+.3811X; 95% CI($\bar{Y}$)=3.9550±4.3446; r=.76**

## Basal Cover versus Loop-Frequency . . . Harvey Valley

Seventy linear regressions with related correlation coefficients were made to relate loop-frequency and basal cover measured by point quadrat in three vegetation types (table 1). None of the correlation coefficients were significant with the constraints previously defined. Thus, there was not an acceptable relationship between the two measurement techniques for the three vegetation types.

The relationships between basal cover measured by point quadrat and loop-frequency were similar to those identified comparing basal cover measured by line intercept and frequency. In all cases, loop-frequency provided a positive bias for all vegetation combinations (table 3). Generally, it was much higher with meadow-type vegetation than the other two types. Here the plants, except one of the grasses, were small in basal area, resulting in an excessively high overrating by the loop-frequency technique.

The bias relationship for the soil category in the open grassland and the litter category in the pine-bunchgrass were near unity, indicating that both methods were providing similar estimates of these items in the community (table 3). However, the extreme variation in bias ratios among species and vegetation classes between the point quadrat and loop-frequency sampling techniques within and among the three vegetation types indicates that the relationship between the two techniques is of limited value.

## Foliar Cover versus Loop-Frequency . . . Carter Mountain

To test the relationship between loop-frequency and foliar cover, 15 linear regressions with related correlation coefficients were made for combinations of exclosure sites and species. None of the correlation coefficients were significant with the constraints previously defined. Thus, there is no apparent acceptable relationship between the two measurement techniques in alpine vegetation.

The bias between loop-frequency and foliar cover ranged from 0.5 for alpine avens to 6.0 for Junegrass (table 4). For individual plant classes, the bias ratio was 2.9, 3.0, and 1.6 for grasses, grasslikes, and forbs, respectively. Due to the wide range in bias within the same group of species, loop-frequency could not be converted to foliar cover by a mean bias estimate.

Loop-frequency can be expected to be only haphazardly related to foliar cover. The loop is measuring presence or absence of vegetation at the ground surface without regard to aboveground configuration. Theoretically there should be no change in loop-frequency provided seasonality does not alter plant community structure or composition (Greig-Smith 1964).

Foliar cover is an estimate of aboveground leafage and will vary with seasons from year to year, depending on growing conditions and animal grazing. If the area were sampled when the vegetation had attained its maximum

Table 2.--Magnitude and variability of mean frequency, cover, and bias between 3/4-inch loop-frequency and basal cover by line intercept in a ponderosa pine-bunchgrass type--Manitou

| Species | June 1967 | | | August 1968 | | | June 1969 | | | August 1969 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Freq. | Cover | Bias | Freq. | Cover | Bias | Freq. | Cover | Bias | Freq. | Cover | Bias |
| | Percent | | | Percent | | | Percent | | | Percent | | |
| All grasses: | 26.3 | 12.5 | 2.1 | 29.5 | 14.8 | 1.9 | 32.6 | 17.2 | 1.8 | 31.4 | 15.1 | 2.1 |
| Blue grama | 18.5 | 9.1 | 2.0 | 20.8 | 9.5 | 2.2 | 23.5 | 11.4 | 2.0 | 20.4 | 10.0 | 2.0 |
| Arizona fescue | 0.3 | 0.1 | 3.0 | 1.0 | 0.6 | 1.6 | 1.1 | 0.5 | 2.2 | 0.8 | 0.5 | 1.6 |
| Mountain muhly | 6.1 | 2.8 | 2.2 | 6.9 | 4.0 | 1.7 | 7.2 | 4.9 | 1.4 | 8.6 | 3.9 | 2.2 |
| Grasslikes (sedge): | 0.4 | 0.1 | 4.0 | 1.2 | 0.5 | 2.4 | 2.0 | 0.1 | 20.0 | 1.8 | 0.3 | 6.0 |
| All forbs: | 20.2 | 6.4 | 3.2 | 14.9 | 3.6 | 4.1 | 16.7 | 4.4 | 3.8 | 14.0 | 4.8 | 2.9 |
| Pussytoes | 10.5 | 4.9 | 2.1 | 5.0 | 2.4 | 2.0 | 8.1 | 3.4 | 2.4 | 8.4 | 4.2 | 2.0 |
| Trailing fleabane | 4.2 | 0.3 | 14.0 | 5.4 | 0.4 | 13.5 | 2.5 | 0.2 | 12.5 | 2.8 | 0.1 | 28.0 |
| Fringed sagebrush | 2.3 | 0.4 | 5.8 | 2.1 | 0.4 | 5.2 | 1.9 | 0.6 | 3.2 | 1.6 | 0.4 | 4.0 |
| All plants: | 46.9 | 19.0 | 2.4 | 45.6 | 18.9 | 2.4 | 51.3 | 21.7 | 2.4 | 47.2 | 20.2 | 2.3 |

Table 3.--Magnitude and variability of mean frequency, cover, and bias between 3/4-inch loop-frequency and basal cover by point-quadrat--Harvey Valley

| | Open grassland | | | Pine-bunchgrass | | | Meadow | | |
|---|---|---|---|---|---|---|---|---|---|
| Species | Freq. | Cover | Bias | Freq. | Cover | Bias | Freq. | Cover | Bias |
| | Percent | | | Percent | | | Percent | | |
| All grasses: | 8.0 | 2.9 | 2.8 | 3.9 | 1.0 | 3.9 | 17.4 | 1.7 | 10.2 |
| Thin bentgrass | -- | -- | -- | -- | -- | -- | 3.5 | 0.1 | 35.0 |
| Tufted hairgrass | -- | -- | -- | -- | -- | -- | 4.5 | 1.2 | 3.8 |
| Idaho fescue | 1.4 | 0.8 | 1.8 | -- | -- | -- | -- | -- | -- |
| Pull-up muhly | -- | -- | -- | -- | -- | -- | 8.0 | 0.3 | 26.6 |
| Bottlebrush-squirreltail | 1.0 | 0.5 | 2.0 | 0.6 | 0.3 | 2.0 | -- | -- | -- |
| Western needlegrass | 5.2 | 1.6 | 3.3 | 2.8 | 0.6 | 4.6 | -- | -- | -- |
| All grasslikes: | 3.0 | 1.5 | 2.0 | 2.9 | 1.9 | 1.5 | 32.3 | 2.6 | 12.4 |
| Nebraska sedge | -- | -- | -- | -- | -- | -- | 11.9 | 1.1 | 10.8 |
| Ross sedge | 3.0 | 1.5 | 2.0 | 2.9 | 1.9 | 1.5 | -- | -- | -- |
| Wire rush | -- | -- | -- | -- | -- | -- | 10.2 | 0.5 | 20.4 |
| All forbs: | 1.0 | 0.5 | 2.0 | 0.2 | 0.2 | 1.0 | 7.6 | 0.5 | 15.2 |
| Pussytoes | 0.5 | 0.2 | 2.5 | -- | -- | -- | -- | -- | -- |
| Woolly mules-ear | -- | -- | -- | 0.2 | 0.1 | 2.0 | -- | -- | -- |
| All shrubs: | | | | | | | | | |
| Basal | -- | -- | -- | 1.3 | -- | -- | -- | -- | -- |
| Crown | 2.2 | 0.9 | 2.4 | 4.9 | 3.3 | 1.5 | -- | -- | -- |
| Total plants (+ basal shrub): | 12.0 | 4.9 | 2.4 | 8.3 | 3.1 | 2.6 | 57.3 | 4.8 | 11.9 |
| Soil | 56.3 | 51.3 | 1.1 | 14.7 | 19.8 | 0.7 | 9.5 | 15.5 | 0.6 |
| Litter | 13.3 | 25.0 | 0.5 | 59.5 | 55.2 | 1.1 | 22.8 | 79.5 | 0.3 |

growth with essentially no grazing, one would obtain an estimate of maximum foliar cover. In contrast, if an area were sampled before maximum growth had been obtained, or at any stage of growth coupled with grazing, a different estimate of foliar cover would be obtained. Similarly, variation in growing conditions from year to year would result in differences in foliar cover. Loop-frequency, on the other hand, should change only as an established plant is destroyed provided the point of observation remains constant. Current-year grazing should have negligible effects upon frequency of perennial plants, because basal and not foliar hits are usually considered by loop-frequency.

**Herbage Production versus Loop-Frequency . . . Wild Bill**

One hundred seventy-five linear regression-correlation analyses were made to test the relationship between loop-frequency and herbage production; 15 were significant (table 1). Seven of the 15 correlations occurred when comparing the two techniques for Arizona fescue and mountain muhly. However, there was no consistent relationship from year to year over the 4-year period of measurement. This indicates evidence of year confounding; the frequency-production relationship was different each year.

Production varies within and among growing seasons, depending on climatic conditions. For example, a wet year produces high yields, a dry year produces low yields, yet loop-frequency of the plant population may remain essentially the same provided the absolute population does not increase or decrease. If we try to estimate production from loop-frequency, the production estimates for both the high- and low-yield years could be similar.

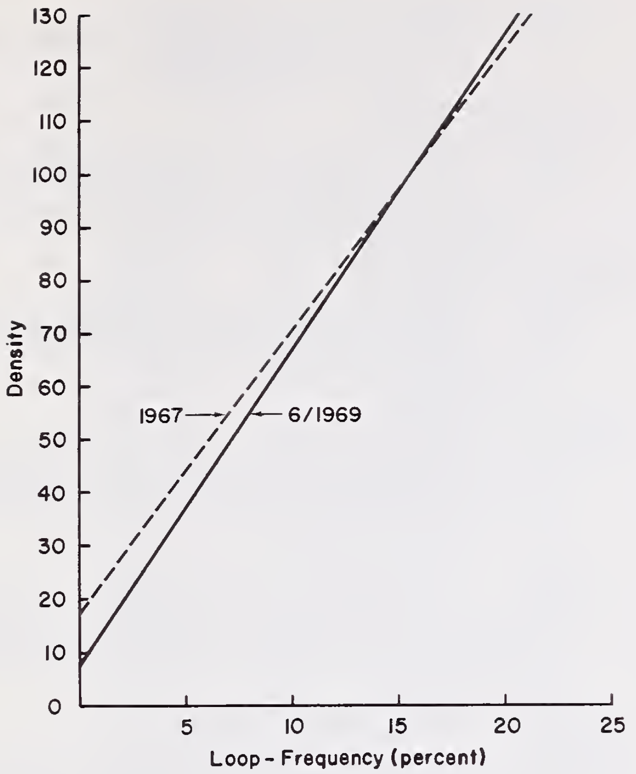



*Figure 3.--Loop-frequency (X) versus density (Y) measured by plot frame for mountain muhly; two measurement periods -- Manitou. (CI for β not shown)*

*1967: $Y=17.75+5.2458X$; 95% $CI(\bar{Y})=50.0900+37.3505$; $r=.75^{**}$*
*6/1969: $Y= 7.28+5.9414X$; 95% $CI(\bar{Y})=50.5000\pm39.9837$; $r=.86^{**}$*

Table 4.--Magnitude and variability of mean frequency, cover, and bias between 3/4-inch loop-frequency and ocular foliar cover in an alpine type--Carter Mountain

| Species | Freq. | Cover | Bias |
|---|---|---|---|
| | Percent | Percent | |
| All grasses: | 10.2 | 3.5 | 2.9 |
| Junegrass | 3.6 | 0.6 | 6.0 |
| Bluegrass | 5.5 | 1.5 | 3.6 |
| All grasslikes: | 8.4 | 2.8 | 3.0 |
| Needle-leaf sedge | 6.7 | 1.4 | 4.7 |
| All forbs: | 50.7 | 31.5 | 1.6 |
| Twinflower sandwort | 6.3 | 3.3 | 1.9 |
| Alpine avens | 2.5 | 5.3 | 0.5 |
| Whiproot clover | 12.6 | 9.4 | 1.3 |
| Total plants: | 69.3 | 37.8 | 1.8 |

**Density versus Loop-Frequency...Manitou**

Of the 96 correlations that tested the relationship between loop-frequency and plant density, 26 were significant (table 1). Only two occurred for one species, mountain muhly, for the two measurement periods (fig. 3). However, confidence intervals showed no reliable relationship.

The remainder of the significant correlation coefficients occurred inconsistently throughout the data.

## Conclusion

When loop-frequency was tested against basal cover estimated by line intercept, 32 percent of the correlation coefficients obtained were significant ($P = 0.05$; $r \geq 0.75$). No significant correlations were obtained when loop-frequency was tested against either basal cover estimated by point quadrat, or foliar cover obtained by ocular estimation. Testing loop-frequency against herbage production gave only 9 percent of the correlations as significant. When loop-frequency was compared to density, 27 percent of the correlations were significant.

Linear regression-correlation analyses of data indicated no reliable relationships between loop-frequency and the other four plant community vegetation characteristics measured. This is confirmed by the lack of consistent correlation coefficients, lack of consistent confidence intervals for slope, and very wide confidence intervals for mean value of Y between measurement dates, or among specific items.

We agree with others that there is bias in the loop method. Since the 3/4-inch loop is really a small plot with area, it overrates most plants and usually underrates soil surface factors in an unpredictable way when compared to cover. With a constant plot size, the bias varies with plant basal diameter as well as other attributes. The bias generally decreases when plant size increases and approaches unity for large plants.

Therefore, on the basis of this work, no apparent reliable relationships existed between loop-frequency and techniques which are often used to measure various plant community characteristics. Three-quarter-inch loop-frequency, therefore, should not be used as an estimate or an index of those characteristics.

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Frequency measured by the 3/4-inch loop technique was compared to estimates of plant basal cover, foliar cover, herbage production, and density. The relationship between loop-frequency and the other parameters were rarely significant or consistent as determined by regression and correlation. Loop-frequency unpredictably overrated foliar and basal plant cover on the basis of ratio estimates, a relative measure of bias. Therefore, frequency estimated by the 3/4-inch loop technique can be equated only to itself and not used to make inferences about other plant community parameters.

**Keywords:** Loop-frequency, plant basal cover, plant foliar cover, herbage production, plant density, bias (ratio estimates).

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## Common and Botanical Names of Plants Mentioned

### Grasses

| | |
|---|---|
| Bentgrass, thin | *Agrostis diegoenis* Vasey. |
| Bluegrass | *Poa* spp. L. |
| Fescue, Arizona | *Festuca arizonica* Vasey. |
| Fescue, Idaho | *Festuca idahoensis* Elmer. |
| Grama, blue | *Bouteloua gracilis* (H.B.K.) Lag. |
| Hairgrass, tufted | *Deschampsia caespitosa* (L.) Beauv. |
| Junegrass | *Koeleria cristata* (L.) Pers. |
| Muhly, mountain | *Muhlenbergia montana* (Nutt.) Hitchc. |
| Muhly, pull-up | *Muhlenbergia filiformis* (Thurb.) Rydb. |
| Needlegrass, western | *Stipa occidentalis* Thurb. |
| Squirreltail, bottlebrush | *Sitanion hystrix* (Nutt.) J. G. Sm. |
| Wheatgrass, crested | *Agropyron cristatum* (L.) Gaertn. |
| Wheatgrass, intermediate | *Agropyron intermedium* (Host.) Beauv. |

### Grasslikes

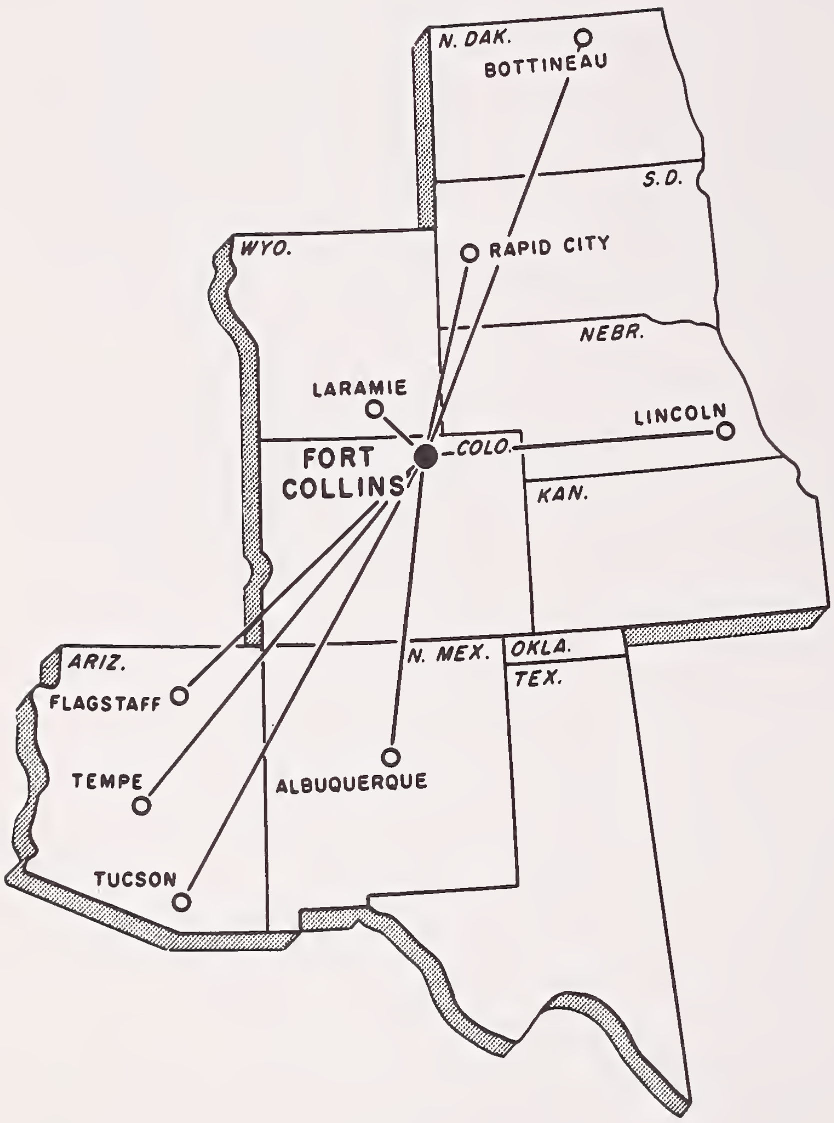
| | |
|---|---|
| Rush, wire | *Juncus balticus* Willd. |
| Sedge | *Carex* spp. L. |
| Sedge, Nebraska | *Carex nebrascensis* Dewey |
| Sedge, needle-leaf | *Carex obtusata* Lilj |
| Sedge, Ross | *Carex rossii* Boott. |

### Forbs

| | |
|---|---|
| Avens, alpine | *Geum rossii* R. Br. |
| Clover, whiproot | *Trifolium dasyphyllum* T. & G. |
| Fleabane | *Erigeron* spp. L. |
| Fleabane, trailing | *Erigeron flagellaris* A. Gray |
| Mules-ear, woolly | *Wyethia mollis* Gray |
| Pussytoes | *Antennaria* spp. Gaertn. |
| Sandwort, twinflower | *Arenaria obtusiloba* (Rydb.) Fern. |

### Shrubs and Trees

| | |
|---|---|
| Ceanothus, Fendler | *Ceanothus fendleri* A. Gray |
| Pine, ponderosa | *Pinus ponderosa* Laws. |
| Sagebrush, big | *Artemisia tridentata* Nutt. |
| Sagebrush, fringed | *Artemisia frigida* Willd. |
| Sagebrush, silver | *Artemisia cana* Pursh. |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BOTTINEAU
S.D.
WYO.
RAPID CITY
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FLAGSTAFF
TEMPE
ALBUQUERQUE
TUCSON